Heterogeneity in the relationship between happiness and age: Evidence from the German Socio-Economic Panel

Gregori Baetschmann*

University of Zurich, Department of Economics

This version: November 11, 2011

Abstract: This paper studies the evolution of life satisfaction over the life course in Germany. It clarifies the causal interpretation of the econometric model by discussing the choice of control variables and the underidentification between age, cohort and time effects. The empirical part analyzes the distribution of life satisfaction over the life course at the aggregated, subgroup and individual level. To the findings: On average, life satisfaction is mildly decreasing up to age fifty-five followed by a hump shape with a maximum at seventy. The analysis at the lower levels suggests that people differ in their life satisfaction trends, whereas the hump shape after age fifty-five is robust. No important differences between men and women are found. In contrast, education groups differ in their trends: highly educated people become happier over the life cycle, where life satisfaction decreases for less educated people.

Keywords: aging, life satisfaction, well-being, happiness methodology

JEL Codes: C23, I31, D91

* I would like to thank Rainer Winkelmann for many helpful suggestions which improved this article.
Address for correspondence: University of Zurich, Department of Economics, Zürichbergstr. 14, CH-8032 Zürich, Switzerland, ☎ +41 44 634 2295, 🖂 gregori.baetschmann@econ.uzh.ch

1 Introduction

This paper contributes to the recent literature on the evolution of individual satisfaction over the life cycle.[1] The most prominent hypothesis is that of a U-shape relation between age and happiness. Detailed studies of the relationship, especially for Germany, have confirmed the U-shape over a long range of the life course but have found another downturn at the end of life (Wunder et al. (2009), Van Landeghem (2009), Fischer (2009), Gwozdz and Sousa-Poza (2009)). Knowing how life satisfaction evolves helps to answer questions like "what is the probability that well-being decreases in the next ten years for a currently 40 year old woman?" or "how happy will I be in twenty years?". Further, it can help to optimize saving decisions. For instance, taking into account the U-shape could help people avoid oversaving for old age.

A key shortcoming of the previous literature is the neglect of heterogeneity in the relationship between age and life satisfaction. With few exceptions (Mroczek and Spiro (2005), Schilling (2006)) the conducted studies have only looked at the central tendency of well-being over the life course at the aggregate level. But seeing a U-shape for the average does not mean that such a relationship is representative for the individual. It is possible that a U-shape results from averaging over individual life cycle paths which are themselves not U-shaped. Moreover, it is possible that age influences the whole distribution of life satisfaction and not only the location.

Using the longest running panel household survey with continuous information on life satisfaction so far, the German Socio-Economic Panel (GSOEP), it becomes possible to trace individual satisfaction levels for up to 26 years, and hence, in principle, to estimate the relationship between age and life satisfaction at the individual level using time series methods. A further advantage of the GSOEP data is that they include information on the entire adult population (those age 20 or above), including the very old. For example seven per cent of the sample (more than 20'000 observations) are older than 70 years. This broad coverage is important for testing the hypothesis of a second turning point, i.e. a decrease in life satisfaction at high age.

[1] The terms life satisfaction, happiness and well-being are used interchangeable in this paper. For a summary of the literature, see for example Blanchflower and Oswald (2007).

The key contributions of the paper are as follows: First, I replicate the findings in the literature regarding the relationship between age and average life satisfaction in a general semi-parametric model. Second, I provide an extended analysis of heterogeneity in the life course of satisfaction, using evidence from four types of models: dispersion as dependent variable; analysis by subgroups; latent class analysis; and individual level regressions.

The findings of the paper are compatible with a U-shape over most of a person's adult life time. However, a more detailed analysis reveals a mild downward trend up to around 55, followed by a distinct increase. After the age of 70, the curve is clearly falling. The study of the distribution of well-being shows a mixed picture. The fraction of people with a very high satisfaction level is falling over the life course. To a lesser extent, this is also true for the fraction of people with a low satisfaction level. Together, this results in a decreasing dispersion in life satisfaction between people over the life course.

Whereas men and women show a very similar development over the life course, education groups differ strongly. People with low education seem to suffer from a steady decline in life satisfaction, while well educated people become happier. However, the hump shape after 55 can be found in all education groups. The result of the finite mixture model confirms the hypothesis that heterogeneity between people can be primarily found in the trend over the life cycle, whereas less heterogeneity exists in the hump shape after 55. Another important finding is that the length a person spent in the panel strongly affects the response. This duration effect, the high variance at the individual level, and the rough measurement of life satisfaction are probably the reasons why investigating the relationship between age and life satisfaction at the individual level provides no clear insights.

2 Modeling life satisfaction over time

Any study attempting to identify and estimate the relationship between age and life satisfaction needs to take a stance on a number of issues. First, what variables to condition on; second, how to deal with the fundamental identification problem between the effects of age, cohort and time, and whether or not to include individual fixed effects; third, to define the relevant level of aggregation; and fourth, what assumptions to make regarding the econometric model, for a given set of regressors: parametric versus semi-parametric, and linear regression versus non-linear ordered probit or ordered logit models. The following sub-sections provide a discussion of each of these four points, their treatment in the existing literature as well as the position adopted in the present paper.

2.1 Conditional vs. unconditional effects

This paper focuses on the question of how life satisfaction has evolved over the life course in Germany in recent years, because I think that results from such an inquiry can be extrapolated and help predicting the evolution of life satisfaction in the near future in Germany and other advanced industrial countries. To get an answer to the question of how life satisfaction has evolved, one essentially needs to follow different people and record their well-being levels. This is the unconditional approach.

In the conditional approach, the researcher is trying to hold some individual level characteristics, like income, health or marital status, constant in order to get a "ceteris paribus" interpretation. But these variables are potential channels through which age affects life satisfaction. Holding individual level variables constant can therefore be highly misleading. Comparing a 50 year old man with three children and a monthly income of $20,000 with a man with the same characteristics but only age 20, hardly helps to identify the effect of age on life satisfaction. The focus on the unconditional age effect is in line with the view expressed by Glenn (2009), Easterlin (2006), and Easterlin and Sawangfa (2007), and in contrast to the approach of Blanchflower and Oswald (2008). Of course, if it is the goal of the analysis to identify the channels through which age influences life satisfaction, it is meaningful to include individual level covariates. This paper concentrates on the evolution of well-being over the life course *per-se*, and not on the causal channels.

Nevertheless, there are some variables for which one should control in the econometric model. Year of birth is correlated with age and has probably also an effect on life satisfaction but is surely not a channel through which age influences happiness. Thus the econometric model should control for cohort effects (see e.g. Blanchflower and Oswald (2008) for a discussion). There is also recent evidence that "panel learning" can have a substantial effect on the response behavior by persons. Panel learning means that people change their responses over time just because they have participated repeatedly in the survey, i.e., even if the underlying feature one wants to measure is unchanged. In the context of life satisfaction, Kassenboehmer and Haisken-DeNew (2010) found a negative effect of time spent in the panel. They conjecture that confidence in the interviewer may rise with each additional interview, which leads to more honest (in this case lower) answers to the life satisfaction question. Interestingly, this panel duration effect has been ignored by much of the previous literature, including the studies by Wunder et al. (2009) and Ree and Alessie (2011), putting a serious question mark behind the findings of these papers.

A further controversial question is whether or not one should control for time effects. The time effect is often split into a shock (for example business cycle) and a trend (e.g. long run economic growth). For example, if the observation period falls together with an economic recession, it looks as if people become unhappier as they get older. However, if the observation period is long enough and different cohorts are tracked, there is no reason why the shocks should be correlated with age. Regarding the long-term trend, it seems pointless to compute age-profiles that exclude the long-term trend, as time and age move in unisono. Arguably, therefore, one should not condition on the trend but rather focus on the combined effect of age and time in order to predict future age-profiles.

2.2 A fundamental identification problem

In an additive model with age, cohort and time, it is not possible to disentangle the linear effect of these three variables, whereas the deviation from the linear effects of each of the three variables is identified. This was formally shown in McKenzie (2006) in a general non-parametric framework. The essence of the argument can be demonstrated in a simple model with linear and quadratic terms:

$$y = \beta_0 + \beta_a age + \gamma_a age^2 + \beta_c cohort + \gamma_c cohort^2 + \beta_t time + \gamma_t time^2 + \epsilon \tag{1}$$

Because $age = cohort + time$, there exists a multicollinearity problem between the three variables. This means that it is not possible to identify β_a, β_c, and β_t separately. If one of the three linear terms is dropped, the regression can be run, but the coefficient on the other two remaining linear terms combine their own effect and the effect of the dropped variable. Clearly, $age^2 \neq cohort^2 + time^2$ (unless one of the terms on the right is zero), and hence there is no problem of multicollinearity here. The same holds true for higher order terms. Thus the linear effect of the three variables cannot be disentangled, whereas deviations from the linear effects are identified.

Ree and Alessie (2011) argue that it is thus not possible to assess the hypothesis of a U-shape but only the hypothesis of a convex relationship between age and happiness. Convexity is a weaker claim than U-shape. In the simple example above where happiness is a linear function of *age* and *age*^{2}, convexity means that $\gamma_a > 0$. A U-shape relationship further requires that a minimum exists ($\beta_a < 0$), and that the minimum lies in the observed age range, thus $-\beta_a/(2\gamma_a) \in [20, 80]$. Convexity is necessary but not sufficient for a U-shape. If β_a is not identified, it is hence only possible to test one requirement of a U-shape, namely the convexity, but not to test for a U-shape itself. Of course, if convexity is rejected, then so is the U-shape.

The argument of Ree and Alessie (2011) is formally correct. However, one has to ask, if this unidentified isolated age effect is really the effect we are interested in. As argued above, this age effect, which is fully disentangled from the time effect, is not interesting and has no clear interpretation. The underlying reason for the lack of a meaningful or causal interpretation is that it is not possible to become older without proceeding in time. In contrast, the age effect combined with the estimated linear time effect is interesting and useful. For example, if a person wants to predict his well-being level in ten years, he is not interested in the isolated effect of age but in the total effect of age and time. For him, it is not meaningful to assume that the social and economic conditions, for which the time variable is a proxy for, will be the same as today. And the best estimate for the effect of these changing conditions in the future is probably the linear time effect in the last years. This effect is estimated by dropping *time* from (1), in which case *age* estimates $\beta_a + \beta_c$.

Another question is if one should include individual fixed effects into the econometric model. It can be argued that this does more harm than good in the present case. First, there is no obvious reason (for example a selection problem), why one should include individual fixed effects into the econometric model. If the sampling process and the cohorts are stable over time, the cohort variable will control for systematic correlations between age and the individual fixed effects. Second, including individual fixed effects into the econometric model leads to a high conditional correlation between age and panel duration. The panel duration effect would then be identified only from people who do not take part in the survey in one year but return in the next. There are relatively few such cases. Without individual fixed effects, the main variation in the panel duration results from various refreshment samples, where new subjects of various ages were recruited at different points in time.

2.3 Aggregation problem

Phenomena at the aggregate level or mean effects are often crucial for policy recommendations. However, for explaining and understanding a phenomenon in the aggregate, it is important to link them to patterns on the individual level. In the context of the relation between age and happiness, the difficulty is that different mixtures of distinct individual life course paths can lead to the same aggregate pattern. This problem is illustrated in Figure 1. In scenario A, the population consists of two types, both with a share of 50%. For both types, the evolution of life satisfaction is U-shaped but they differ in the level and curvature. In scenario B, the population consists again of two different types with equal shares. In contrast to the first one, none of the two types has a U-shaped pattern. However, the relation between age and life satisfaction in the aggregate, as represented by the solid line, is the same in both scenarios.

− − − − −− Figure 1 about here − − − − − − −

It is simply not possible to say something about patterns at the individual level by only looking at the aggregate picture. Thus "midlife crisis", for example, would only be a valid explanation for the U-shape in the aggregate in scenario A. An explanation for the second scenario would be that people differ in their discount rates and can choose between two different life cycle paths. People with a high discount rate choose the path with the higher initial life satisfaction level, while people with a low discount rate choose the path with the higher average score.[2]

The literature so far has focused on the aggregate pattern. To the best of my knowledge, the only studies in the age-happiness literature which give some attention to this problem are Mroczek and Spiro (2005) and Schilling (2006). Another study in the happiness lit-

[2]This argument assumes that satisfaction is period specific, i.e., anticipation of future increases or reductions in satisfaction do not enter present satisfaction.

erature touching this problem is the paper of Clark et al. (2005), which tries to capture heterogeneity in the income effect on life satisfaction with a finite mixture model.

2.4 Econometric model and estimation

To investigate the relation between age and life satisfaction, an additive model is used throughout the paper. I describe in this section the basic version of the model that focuses on aggregate patterns, as represented by the conditional expectation. In later sections, the model will be modified appropriately in order to enable the study of heterogeneity.

As discussed previously, the included regressors are age (a), year of birth (c for cohort), year of the interview (t for time) and the time spent in the panel up to the interview (d for duration). The dependent variable is a measure of life satisfaction and is denoted by y. A flexible additive model for the expectation of y can be written as:

$$\mathrm{E}(y|a,c,t,d) = \beta_0 + \sum_{k=20}^{80} \beta_k^a I_k^a + \sum_{k=1904}^{1989} \beta_k^c I_k^c + \sum_{k=1984}^{2009} \beta_k^t I_k^t + \sum_{k=1}^{26} \beta_k^d I_k^d, \tag{2}$$

where β_0 denotes the constant and I the indicator function (thus I_k^a, for example, equals 1 if the age variable is equal to value of the indicator k). The model includes a dummy for each category of the four variables, and β stands for the effect of the corresponding dummy.

Two sorts of restrictions have to be imposed to enable estimation:

$$\sum_{k=\min(x)}^{\max(x)} \beta_k^x = 0 \qquad \text{for all } x \in \{a,c,t,d\} \tag{3}$$

$$\sum_{k=1984}^{2009} \beta_k^t k = 0. \tag{4}$$

Equation (3) restricts the total effect of each variable to zero and hence avoids multicollinearity between the dummies. It is functionally equivalent to dropping one dummy of each variable. The second restriction – equation (4) – ensures that the linear effect of the time variable is equal to zero and thus avoids multicollinearity between the linear effects of age, cohort, and time (cf. section 2.2).

The identified linear effects can be directly estimated by reformulating the econometric model. Including a separate term for the trend of each variable and using the identity

$time = age + cohort$ results into the following model:

$$\begin{aligned}\mathrm{E}(y|a,c,t,d) =& \beta_0 + (\beta^a + \beta^t)a + \sum_{k=20}^{80} \beta_k^a I_k^a + (\beta^c + \beta^t)c + \sum_{k=1904}^{1989} \beta_k^c I_k^c + \\ & \sum_{k=1984}^{2009} \beta_k^t I_k^t + \beta^d d + \sum_{k=1}^{26} \beta_k^d I_k^d, \qquad (2')\end{aligned}$$

where β's without subscript denote the trends. To enable estimation, restriction (3) and restrictions equivalent to (4) on cohort, age and duration in addition to time are imposed. Because the variable *time* was replaced by *age* plus *cohort*, the variables *age* and *cohort* estimate their own linear effect plus the time trend.

Both formulas represent the same model, which can be estimated by ordinary least squares (OLS). The well-being variable is usually described as ordered, and the median is normally viewed as the right statistic to characterize the location of an ordered variable.[3] The mean, however, has the advantage to be more sensitive to small changes in the distribution. Previous studies – Ree and Alessie (2011), Wunder et al. (2009), and Van Landeghem (2009) – have found a magnitude of less than one point on the eleven point scale in Germany. Thus it is possible that the location of the distribution changes systematically over the life course, whereas the median is constant. For this reason, the mean is used to study the evolution of average life satisfaction. To allow for dependence between repeated observations of one individual, cluster corrected standard errors are reported.

3 Results

3.1 Data description

The paper uses data from the German Socio Economic Panel (GSOEP). The unique feature of this data set is its long time dimension. At present, it is possible to follow some people for 26 years, from 1984 to 2009. The analysis is conducted with unweighted observations of people, who live in (former) West-Germany and are between 20 and 80 years old. Life

[3] Of course, one could also estimate conditional probability models such as the ordered logit or ordered probit model. The case for such models is not very persuasive in the present context, where there are eleven numbered outcomes (from zero to ten) and cardinal interpretations are desired. See Ferrer-i-Carbonell and Frijters (2004) for a comparison of OLS versus ordered response models in this context.

satisfaction is ascertained with the question "How satisfied are you with your life, all things considered?" that is always asked at the end of the interview.[4] The response is measured on an eleven point scale ranging from 0 (completely dissatisfied) to 10 (completely satisfied). Table 1 shows the distribution of the life satisfaction score and summary statistics of the employed variables. The average happiness score lies slightly over 7, where about 50% of the answers are concentrated on the categories 7 and 8. In contrast, only 8% have a life satisfaction score below 5 (the midpoint of the scale). By construction, people in the sample are born between 1904 and 1989. Nearly half of them are women.

− − − − −− Table 1 about here − − − − − − − −

3.2 Mean

Based on equation (2) and the two technical restrictions (3) and (4), the development of average well-being over the life cycle is analyzed. Figure 2 presents the regression results. As discussed in section 2.2, it is not possible to estimate the linear effect of age, cohort and time separately, whereas the linear effect of duration in the panel poses no problem. As argued above, this underidentification is not as severe as other papers suggest, but it is not clear how to report the results. Because this paper focuses on the age effect, the time trend coefficient is restricted to zero (equation (4)) and is thus captured in the age and cohort effect curves. The terms "age effect with trend", "cohort effect with trend", respectively "time shock effect" are used to refer to the mapped impacts. Additionally, the estimation results for the isolated linear effects (equation (2')) are stated in Table 2. The estimated trends are, in contrast to Ree and Alessie (2011), very small. The linear effects of age and time ($\beta^a + \beta^t$), and cohort plus time ($\beta^c + \beta^t$), respectively, are both 0.003 per additional year. The reason for the differences between the results of Ree and Alessie (2011) and this study is the inclusion of duration in the panel as an additional control variable. Because the magnitude of the linear effects is so small, the changes in the graphs would only be

[4] In German: "Wie zufrieden sind Sie gegenwärtig, alles in allem, mit Ihrem Leben?"

minor if the drifts would be excluded.

– – – – – – Table 2 about here – – – – – – – –

The age effect with trend can be characterized as U-shaped. However, such a description is somewhat oversimplified. A closer inspection shows that the picture fits nicely to previous research results. There is a small but steady decline in the happiness score between age 20 and 55. After this trough – which coincides with the minimum in a sample of eight European countries found by Blanchflower and Oswald (2009) – average happiness increases strongly until the age of 70. Thereafter, the average score falls sharply. Wunder et al. (2009) and Van Landeghem (2009) have also found a local maximum at age 70. The total magnitude of the effect (0.4) is small and thus in line with, for example, Kassenboehmer and Haisken-DeNew's (2010) doubt about the U-shaped relationship. The effect without linear trend is very similar to the one reported by Ree and Alessie (2011) who also used the GSOEP, albeit for the shorter 1986-2007 period. The reason for the fall at the end of life is likely decreasing health. Explaining the increase after 55 is more difficult and calls for more research.

– – – – – – Figure 2 about here – – – – – – – –

The cohort profile with trend, displayed in the lower left panel of Figure 2 is slightly increasing. But otherwise no clear or interesting pattern emerges. This is perhaps also due to the low precision of the estimates which renders the interpretation difficult. The time shock profile mirrors the business cycle. There is a distinct peak right after the German reunification. The low in the first decade of the new millennium overlaps with the burst of the ICT bubble. The correlation between the estimated shocks and the GDP growth in the previous year is over 60%.[5] Again, a very similar profile was found by Ree and Alessie (2011). Among all included variables, the time spent in the panel (duration) has clearly the highest impact on reported happiness. The picture suggests a negative linear effect, corroborating the earlier findings of Kassenboehmer and Haisken-DeNew (2010).

[5] Based on calculations using World Bank (2011) data.

3.3 Distribution and dispersion

To analyze the distribution of the happiness variable, the baseline model – equation (2) together with restrictions (3) and (4) – is applied separately to each category of the life-satisfaction variable. These linear probability models estimate the effect of age on the probability of having a given life satisfaction score, for example "nine", accounting for year of birth, time shocks, and duration. Figure 3 shows the results for the age effect with trend plus constant, where some categories are combined for simplicity. The results for the controls are not shown. There seem to be no common pattern behind the six curves. The probability of being totally happy (having a value of 10) is steadily decreasing over the life course with a plateau between 60 and 65. This decrease can be made responsible for the downward slope of average life satisfaction between 20 and 55 as well as the fall after 70. The decreasing probability of the highest category implies an offsetting increase for the other categories. The greatest change occurs in the probability of having an 8. The hump shape in the mean curve starting at 55 can largely be ascribed to the temporary decline in the probability of having a 3, 4 or 5, i.e. being rather "dissatisfied". Compared to the rather small absolute changes in average happiness, the changes in the distribution are large. The predicted probability of reporting a 10, for example, decreases by fifteen percentage points over the life cycle.

− − − − −− Figure 3 about here − − − − − − −

These findings of decreasing probabilities of low and high life satisfaction scores over the life course imply a steadily shrinking dispersion. To illustrate this, the baseline model is applied to the absolute deviation of the residuals from the mean life satisfaction score regression. Figure 4 shows the results. Dispersion is steadily decreasing in age and is smaller for younger cohorts. As discussed, the linear trend of age, cohort and time cannot be disentangled. The most probable explanation for the two decreasing tendencies is a time trend toward more equality which is mirrored in the graph for the age and the cohort effect. These findings are in line with those of Stevenson and Wolfers (2008) who reported that the dispersion in happiness was shrinking between 1972 and 2006 in the USA, and that happiness is less equally distributed within older cohorts. Compared to age and cohort, duration in the panel and time shocks have only a small effect on dispersion.

− − − − −− Figure 4 about here − − − − − − − −

3.4 Relation in different subgroups

To study heterogeneity in the relationship between age and life satisfaction, the baseline model – equation (2) under restrictions (3) and (4) – is applied to different subgroups. I consider groupings based on gender and years of education. Among the two, gender is clearly exogenous, whereas education may be affected by self-selection.

− − − − −− Figure 5 about here − − − − − − − −

Figure 5 shows the regression results for men and women. The resemblance of all four curves is quite striking. For both genders, the age curve has a minimum at around 55, followed by a distinct hump shape. The greatest difference in the age effect between the sexes can be observed until 55. Where the curve is clearly decreasing for men, the profile is flatter and perhaps upward sloping between 20 and 30 for women. Further, the positive trend in the cohort effects is stronger for women. Otherwise, there are no noticeable differences between the curves.

− − − − −− Figure 6 about here − − − − − − − −

To study heterogeneity depending on education, the population is split along the education dimension into six groups of roughly equal size. Figure 6 shows the results of the age effect with trend in the baseline model for all types. Two patterns stand out: First, the hump at the end of life can be found in all six groups. Second, the linear trend changes systematically. Life satisfaction for the least educated people is clearly downward sloping. However, the negative trend gets less pronounced as education increases, and the drift for people in the most educated group is even positive. Estimating the baseline model for the mean and including an age-education interaction term confirms the finding that the trend for better educated people is more positive (results not shown in the paper). However, one has to be cautious in interpreting the results. Because people can choose education at the beginning of life, one cannot infer that education causes these different life cycle paths. It is also possible that personality traits, like self-discipline, lead to different life course paths as well as variation in education outcomes.

3.5 Finite mixture model

Finite mixture models allow to model heterogeneity depending on unobservable class membership, which does not necessarily depend on observable characteristics like gender or education (a standard reference for finite mixture models is McLachlan and Peel (2000); for previous happiness applications see Clark et al. (2005) or Bruhin and Winkelmann (2009)). Estimating such a model requires specifying the conditional distribution and not just the mean. Because the specification of the distribution is somewhat arbitrary, two different models are estimated, a linear model with normally distributed error terms and an ordered logit model. Where the first model is a direct extension of the linear model employed earlier, the second has the advantage of respecting the support of the dependent variable $(0, 1, \ldots, 10)$. If a simplified version of the model is estimated, both procedures lead to the same qualitative conclusions. Thus I present only the results of the normal linear model. The log-likelihood contribution of person i, who is represented with T_i observations, in the simplified model is

$$\log \left[\sum_{g=1}^{G} \left(\pi^g \prod_{t=1}^{T_i} \frac{1}{\sigma^g} \phi \left(\frac{y_t - \beta_0^g - \sum_{k=21}^{80} \beta_k^{a,g} I_k^{a_t} - \sum_{k=2}^{26} \beta_k^{d,g} I_k^{d_t}}{\sigma^g} \right) \right) \right], \tag{5}$$

where $\phi(.)$ denotes the density function of a standard normally distributed random variable, σ the standard deviation and π^g the probability of belonging to class g. There exist G groups and the subscript g of the parameters indicates that they depend on group membership. Otherwise, the same notation as in equation (2) applies.[6] The log-likelihood function is

[6]The estimated model imposes the restrictions that the time and cohort variables have no effect. This facilitates convergence and is compatible with the theoretical independence between the time shocks and age, and the empirical finding that the cohort effect has no systematic effect on mean life satisfaction (section 3.2). Further, people age 20 polled the first time (hence duration=1) are defined as the base category.

maximized with the EM-algorithm.[7]

Figure 7 shows the estimated effect of age on life satisfaction for one to four latent classes. The upper left graph shows the results for the model with only one class. It is evident that the interpretation of a U-shape followed by a hump shape does not change if the time shocks and the cohort variable are excluded. The striking result of the remaining graphs is that the hump shape after 55 can be found in all latent groups, regardless of the number of allowed classes. The trends over the life cycle, however, differ between the groups. The largest group is always the one with no clear drift.

− − − − −− Figure 7 about here − − − − − − − −

3.6 Individual patterns

The study of the relation between age and life satisfaction on the individual level is complicated by three factors. First, the maximum length one can follow a person is 26 years and it is therefore not possible to study satisfaction over the whole life cycle for any one individual. Second, the variance of the error term is large relative to the expected changes of the mean happiness score. At the individual level, the smallest possible change of the dependent variable is one point. This exceeds the maximal average effect found over the life cycle. Third, duration in the panel has a large effect. But on the individual level, it is not possible to disentangle the duration from the age effect in a credible manner.

The empirical inquiry at the individual level starts therefore by studying the fraction of people at a certainm age, who report at that age a larger (or smaller) happiness that at any other time over the previous ten years. This restricts the analysis to individuals who are observed for at least eleven years. The share of people in the population experiencing a minimum (maximum) is probably overestimated (underestimated), because this analysis ignores the duration effect. However, it is still possible to determine whether the finding of a U-shape followed by a hump shape prevails at the individual level. Figure 8 shows the results. First a short explanation how to read the graph: A value of 20% at the age of

[7]The R-program FlexMix by Bettina Gruen and Freidrich Leisch (2008) was used to estimate the linear finite mixture model.

thirty means that one out of five people, who are at least observed between age twenty to thirty, experiences a minimum at thirty in this period (the minimum has not to be unique). The confidence intervals are not shown for ease of readability (but each estimate is based on more than 1000 observations). The fraction of minimums almost always exceeds the fraction of maximums. The obvious explanation is the neglected duration effect. There is no clear trough at 55 but the fraction of minimums decreases and the proportion of maximums goes up after this age. These small changes are more than offset by the trends after age 68. The fraction of minimums is nearly exploding, and the fraction of maximums shrinks.

− − − − −− Figure 8 about here − − − − − − −

Because the U-shape hypothesis and the corresponding trough have received much attention in the literature, the distribution of minimums for people who are observed between age 48 and 62 are shown in Figure 9, these are about 1000 individuals. The distribution is nearly uniform, with a slight increase with age. This slight trend can again be explained by the neglected negative duration effect. The general pattern suggests that only a small fraction of the individuals reach the minimum at exactly 55.

− − − − −− Figure 9 about here − − − − − − −

To further study heterogeneity at the individual level, a separate model is estimated for each individual and each possible interval of length eleven (thus, in general, more than one model per individual). To keep it simple, the model consists of two linear age terms, one for the first and one for the second half of the interval. Each regression is then characterized as hump shaped (if the first linear term is positive and the second one is negative), U-shaped (if the first linear term is negative and the second one is positive), increasing or decreasing (depending on if both terms are positive or negative). If well-being does not systematically change over the life course, the four curves should be flat. But this is obviously not the case, as can be seen in Figure 10. The picture largely confirms the finding that the hump shape after 55 is the dominant pattern. The fractions are nearly stable until 50 where the U-shape and the increasing patterns start to gain shares. At 55, the fraction of U-shape types reaches a maximum and the fraction of hump shape types a minimum. Shortly after 60, the fraction of decreasing types becomes more and more important.

– – – – –– Figure 10 about here – – – – – – – –

——————— ——————— ———————

4 Conclusion

This paper studies the relationship between age and self-reported well-being not just at the average level, as customary in prior research, but also at the individual level, analysing the differences between individual life cycle paths. The inquiry of heterogeneity at the individual level, while of substantial interest, is hampered by the rough measure of life satisfaction and the related high volatility in individual life cycle paths, as well as by the strong duration effect. Nevertheless, it is safe to conclude that a life cycle pattern with two turning points is prominent at the individual level as well.

Insights into the average evolution of life satisfaction and group differences between individual life cycle paths are more robust. Mean life satisfaction is steadily declining between 20 and 55. After this low, happiness increases strongly until the age of 70, where it starts to fall sharply. The driving force behind the hump shape after 55 is the temporarily diminishing share of rather unsatisfied people. The mild downward trend, on the other side, is mostly due to the falling probability of the "complety satisfied" category. The dispersion in well-being is decreasing in age and year of birth. An explanation of this pattern is the time trend toward more equality.

While the happiness trend over the life course differs between groups of people, whereas the form of the relationship (thus the deviation from the linear trend), is rather stable, namely a hump shape after 55 with a peak at around 70. This conclusion is based on the regression for different education groups as well as the results of the finite mixture model. Gender differences are minor.

Further research should concentrate on the channels through which age affects life satisfaction. Because of the large reporting effect of duration in the panel, repeated cross sectional data are probably most suitable for such a task. The gain from panel data, namely the potential study of individual life cycle paths, can hardly offset this drawback.

References

Blanchflower, D. G. and Oswald, A. J. (2004): “Well-Being over Time in Britain and the US”, *Journal of Public Economics*, **88**, 1359-1386.

Blanchflower, D. G. and Oswald, A. J. (2008): “Is Wellbeing U-shaped over the Life Cycle”, *Social Science and Medicine*, **66**, 1733-1749.

Blanchflower, D. G. and Oswald, A. J. (2009): “The U-Shape without Controls: A response to Glenn ”, *Social Science and Medicine*, **69**, 486-488.

Bruhin, A. and Winkelmann, R. (2009): “Happiness Functions with Preference Interdependence and Heterogeneity: The Case of Altruism within the Famil”, *Journal of Population Economics*, **22**, 1063-1080.

Clark, A. E. (2007): “Born To Be Mild? Cohort Effects Don’t (Fully) Explain Why Well-Being Is U-Shaped in Age”, IZA Discussion Paper No. 3170.

Clark, A. E., Diener, E., Geogellis, Y. and Lucas, R. E. (2008): “Lags and Leads in Life Satisfaction: A Test of the Baseline Hypothesis”, *The Economic Journal*, **118**, 222-243.

Clark, A. E., Etilé, F., Postel-Vinay, F., Senik, C., and Van der Straeten, K. (2005): “Heterogeneity in reported well-being: Evidence from twelve European countries”, *The Economic Journal*, **115**. 118 – 132.

Easterlin, R. A. (2006): “Life cycle happiness and its sources: Intersections of psychology, economics and demography”, *Journal of Economic Psychology*, **27**, 463-482.

Easterlin, R. A. and Sawangfa, O. (2007): “Happiness and Domain Satisfaction: Theory and Evidence”, IZA Discussion Paper No. 2584.

Ferrer-i-Carbonell, A. and Frijters, P. (2004): “How important is methodology for the estimates of the determinants of happiness?”, *Economic Journal*, **114**, 641-659.

Frijters, P. and T. Beaton (2011): “The mystery of the U-shaped relationship between happiness and age”, NCER Working Paper Series 26R.

Fujita, F. and Diener, E. (2005): "Life Satisfaction Set Point: Stability and Change", *Journal of Personality and Social Psychology*, **88**, 158-164.

Fischer, J. AV. (2009): "Happiness and age cycles – return to start…", MPRA paper No. 15249.

Glenn, N. (2009): "Is the apparent U-shape of well-being over the life course a result of inappropriate use of control variables? A commentary on Blanchflower and Oswald (66: 8, 2008, 1733-1749)", *Social Science and Medicine*, **69**, 481-485.

Gruen, B and Leisch, F. (2008): "FlexMix Version 2: Finite mixtures with concomitant variables and varying and constant parameters", *Journal of Statistical Software*, **28**, 1-35.

Gwozdz, W. and Sousa-Poza, A. (2010): "Ageing, Health and Life Satisfaction on the Oldest Old: An Analysis for Germany", *Social Indicator Research*, **97**, 397-417.

Kassenboehmer, S. and Haisken-DeNew J. P. (2010): "Heresy or Enlightenment? The Wellbeing Age U-Shape Effect is Really Flat!" Unpublished manuscript.

McKenzie, D. J. (2006): "Disentangling Age, Cohort and Time Effects in the Additive Model", *Oxford Bulletin of Economics and Statistics*, **68**, 473-495.

McLachlan, G., and Peel, D. (2000): *Finite Mixture Models.* Wiley, New York.

Mroczek, D. K., and Spiro A. (2005): "Change in Life Satisfaction during Adulthood: Findings From the Veterans Affaires Normative Aging Study", *Journal of Personality and Social Psychology*, **88**, 189-202.

Ree, J. and Alessie, R. (2011): "Life Satisfaction and Age: Dealing with Underidentification in Age-Period-Cohort Models", *Social Science and Medicine*, **73**, 177-182.

Schilling, O. (2006): "Development of life satisfaction in old age: another view on the "paradox"", *Social Indicator Research*, **75**, 241-271.

Stone, A. A., Schwartz, J. E., Broderick, J. E. and Deaton, A. (2010): "A snapshot of the age distribution of psychological well-being in the United States", *Proceedings of the National Academy of Sciences*, **107**, 9985-9990.

Stevenson, B. and Wolfers, J. (2008): "Happiness Inequality in the United States", *Journal of Legal Studies*, **37**, 33-78.

Van Landeghem, B. (2009): "The Course of Subjective Well-Being over the Life Cycle", *Journal of Applied Social Science Studies*, **129**, 261-267.

Van Landeghem, B. (2011): "A Test for the Convexity of Human Well-Being over the Life Cycle: Longitudinal Evidence from a 20–Year Panel", *Journal of Economic Behaviour and Organization*, forthcoming.

Winkelmann, L. and Winkelmann, R. (1998): "Why are the unemployed so unhappy? Evidence from panel data", *Economica*, **65**, 1-15.

Wunder, C., Wiencierz, A., Schwarze, J., Küchenhoff, H., Kleyer, S., and Bleninger, P. (2009): "Well-being over the life span: evidence from British and German longitudinal data", IZA Discussion Papers No. 4155.

World Bank (2011): *World Development Indicators*.

Figures

Figure 1: Illustration of the aggregation problem

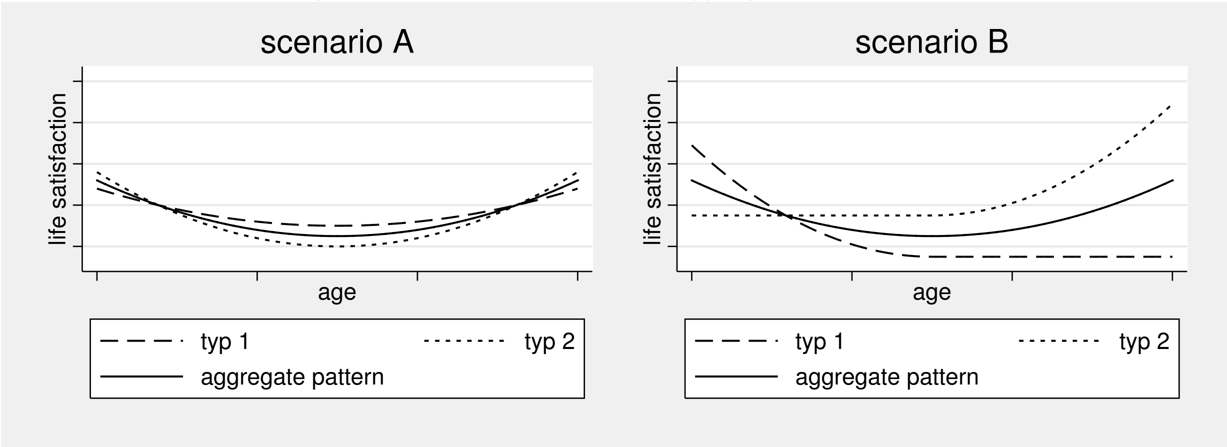
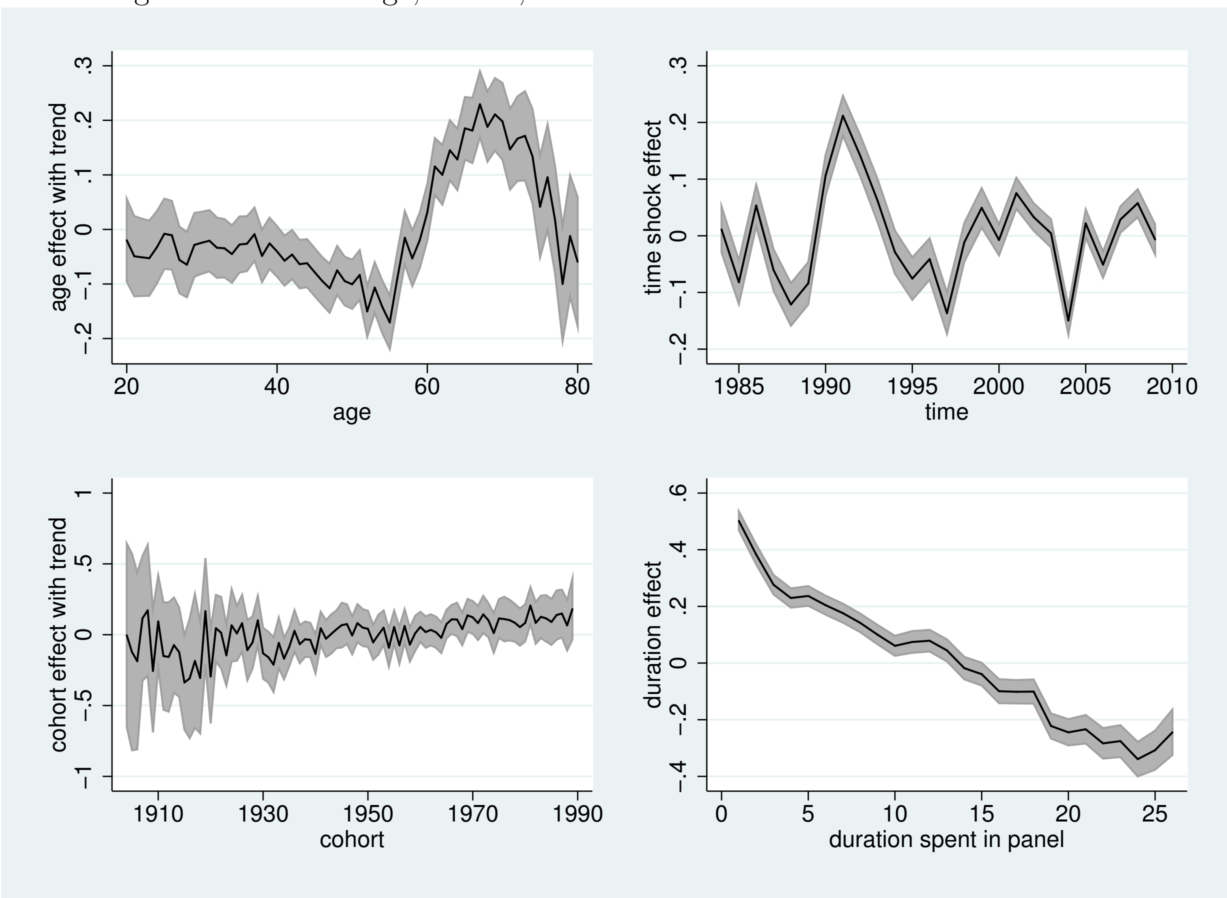
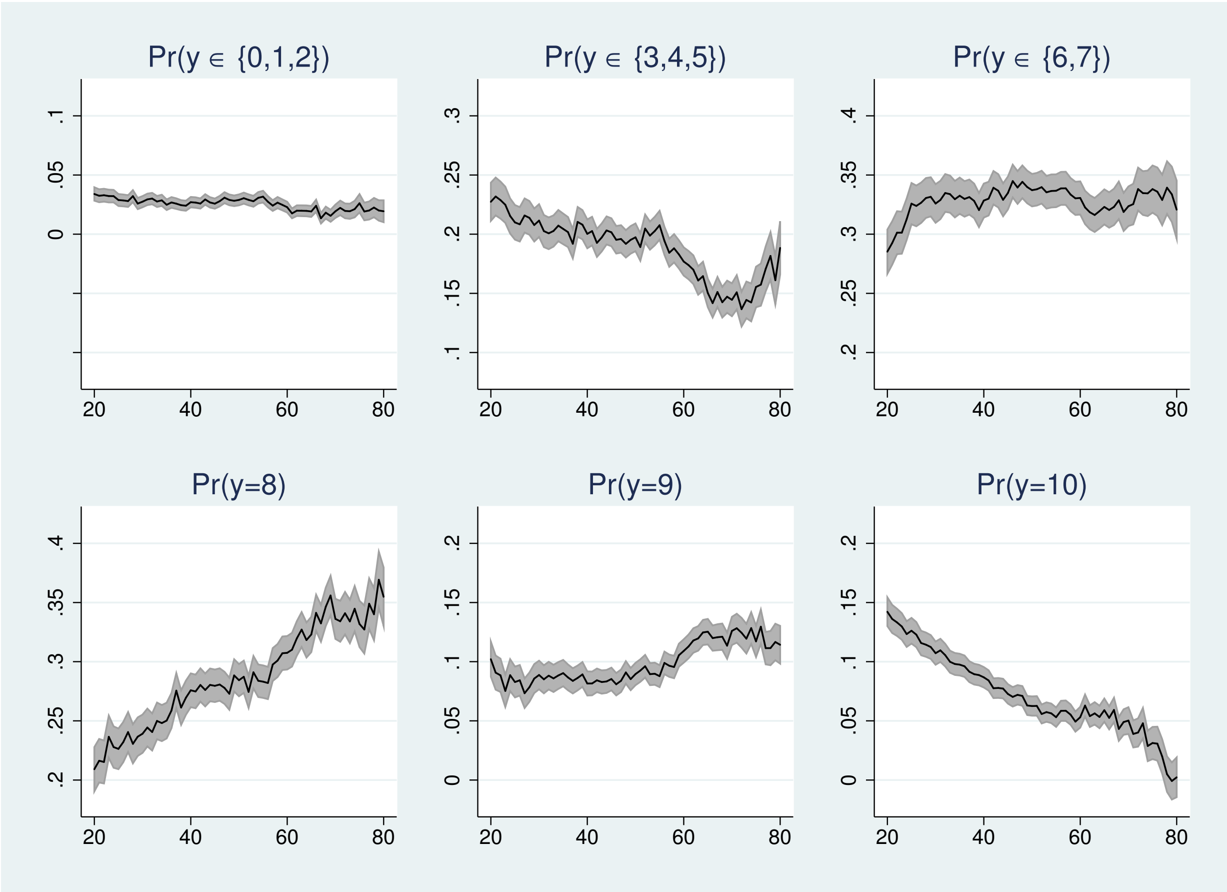


Figure 2: Effect of age, cohort, time and duration on mean life satisfaction



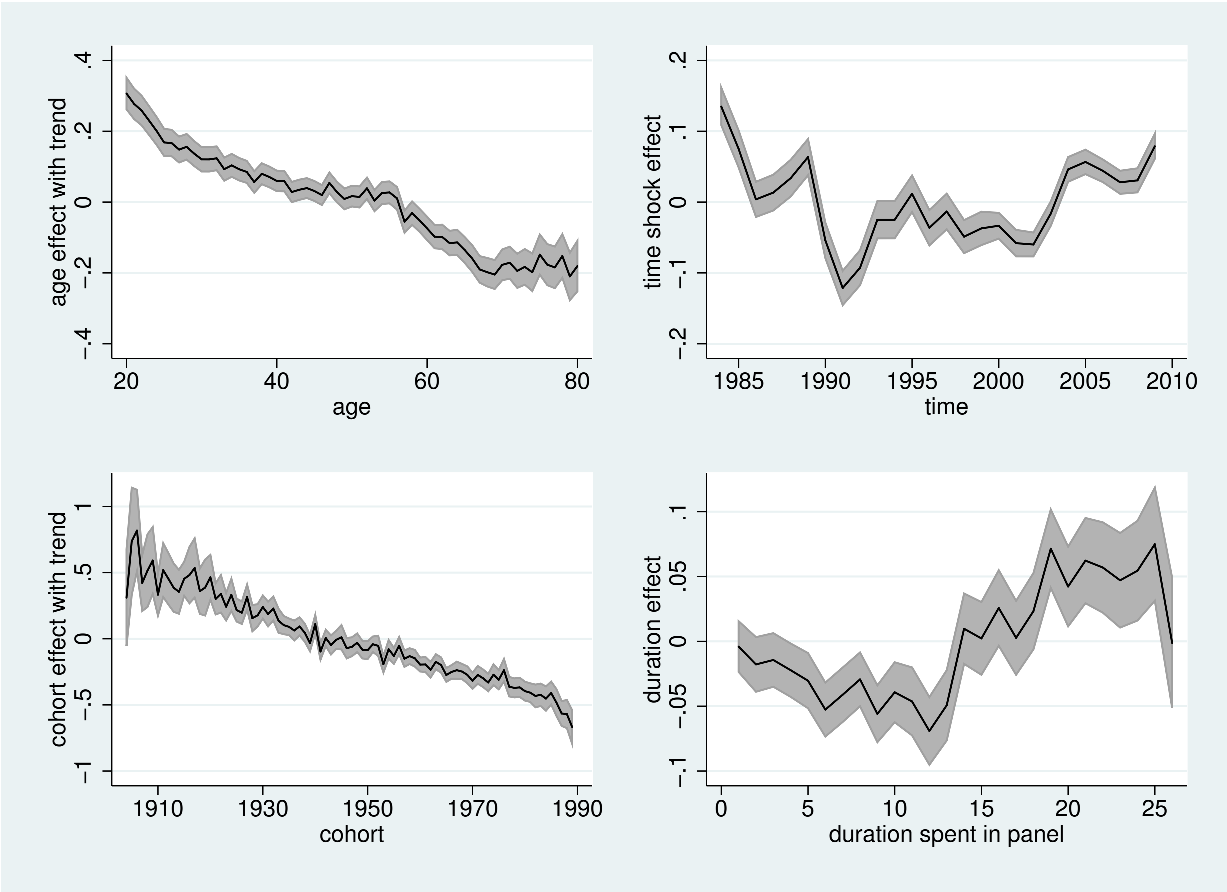
Notes: The black line depicts the estimates of equation (2) under the restrictions (3) and (4). The gray area indicates the 95% confidence intervals computed based on cluster robust standard errors.

Figure 3: Distribution of life satisfaction over the life course



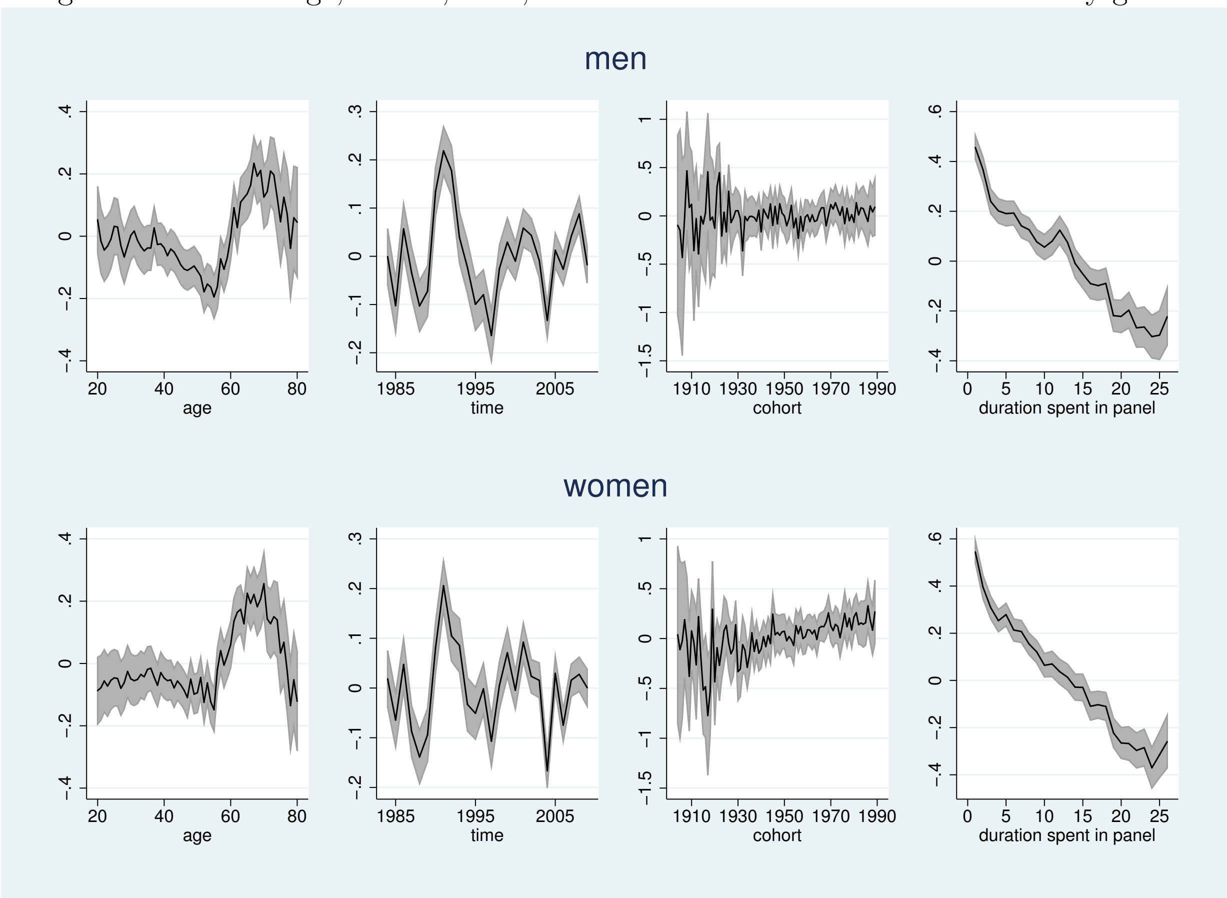
Notes: Results based on linear probability models. The black line depicts the estimated age effect with trend plus constant (equation (2) under restrictions (3) and (4)). The gray area indicates the 95% confidence interval computed based on cluster robust standard errors.

Figure 4: Effect of age, cohort, time, and duration on dispersion of life satisfaction



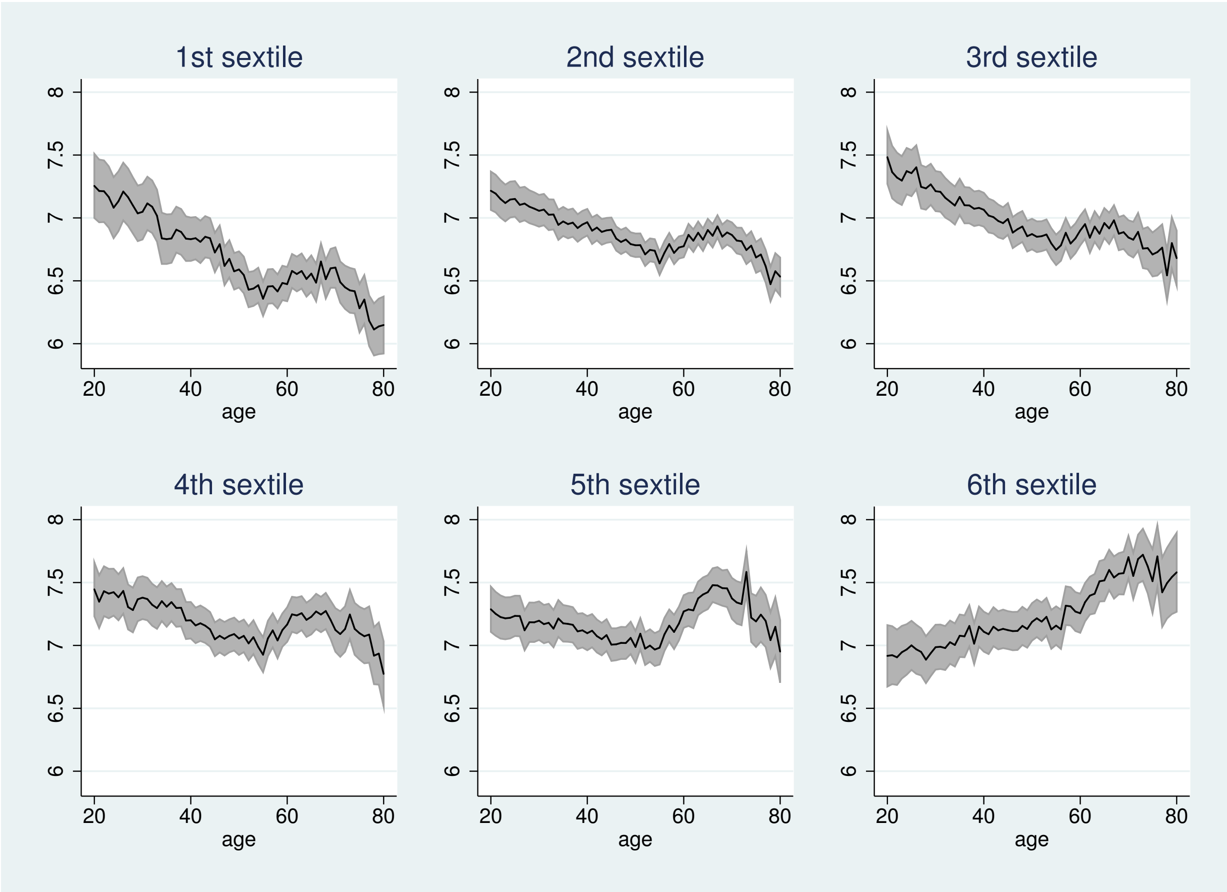
Notes: The dependent variable is the absolute deviation of the residuals from the mean life satisfaction regression. The regression is based on equation (2) under restrictions (3) and (4). The gray area indicates the 95% confidence intervals computed based on cluster robust standard errors.

Figure 5: Effect of age, cohort, time, and duration on mean life satisfaction by gender



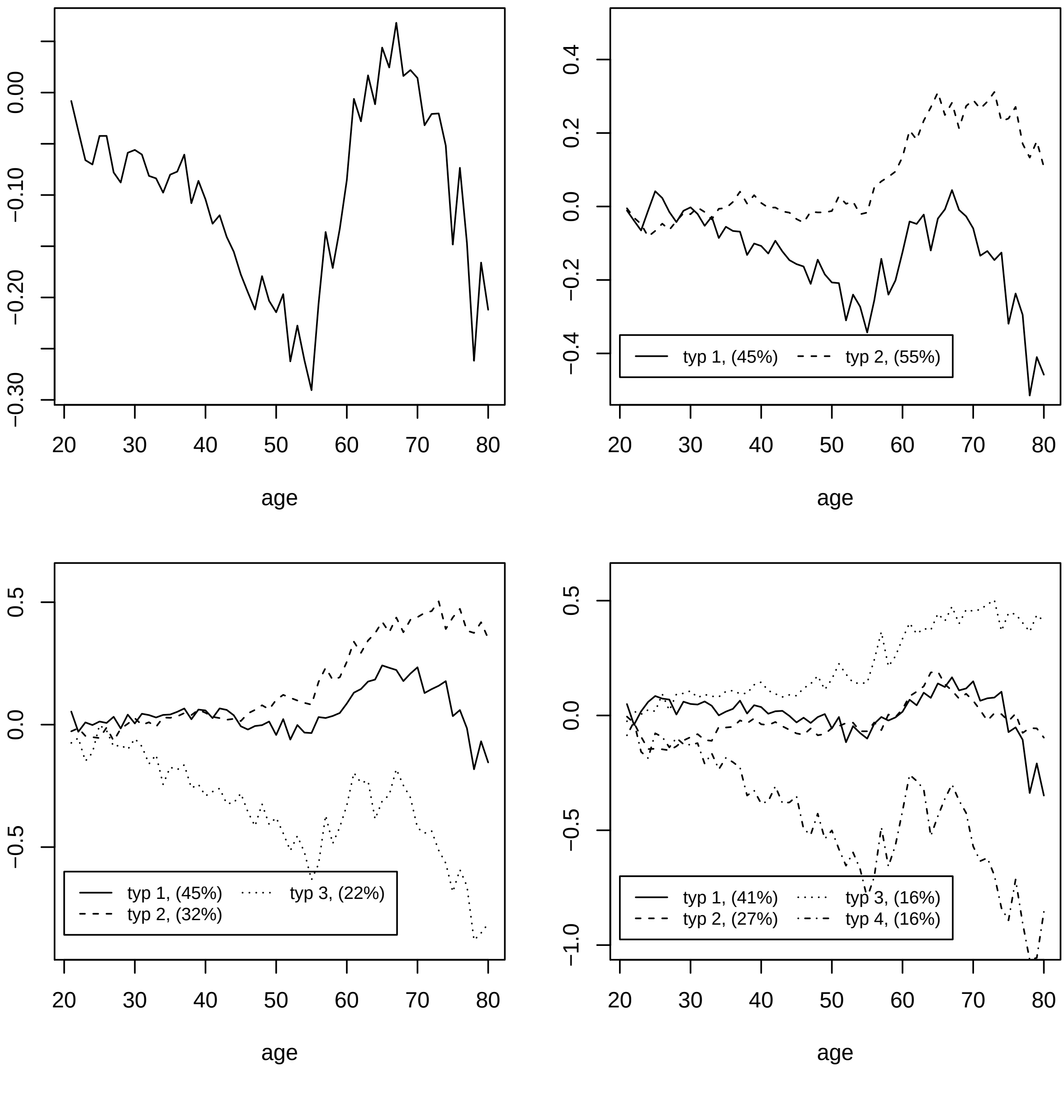
Notes: The upper graph shows the results for men, the lower graph shows the results for women. Otherwise, legend of Figure 2 applies.

Figure 6: Effect of age on mean life satisfaction by education



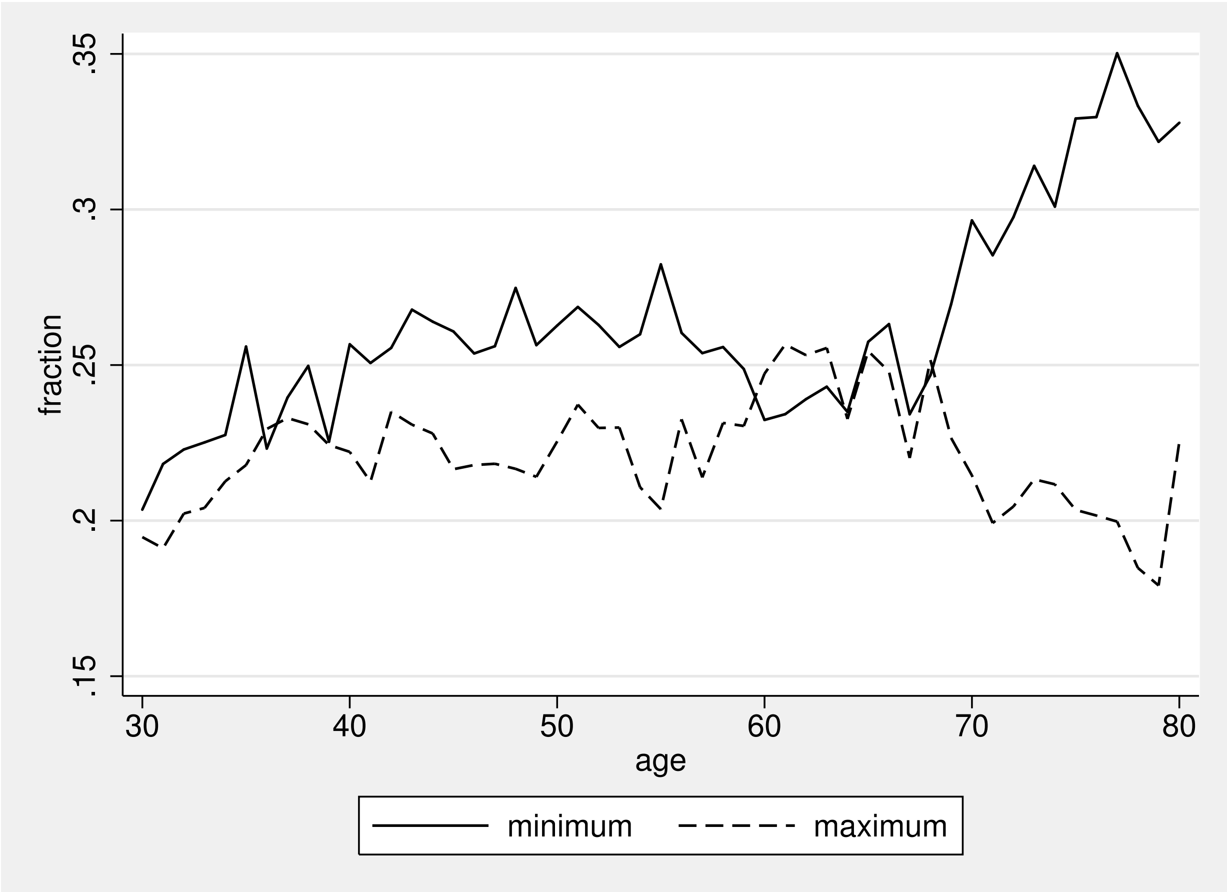
Note: The black line depicts the estimated age effect with trend (equation (2) under restrictions (3) and (4)) plus constant for different education sextiles. The gray area indicates the 95% confidence interval computed based on cluster robust standard errors.

Figure 7: Finite mixture model: Effect of age on mean life satisfaction



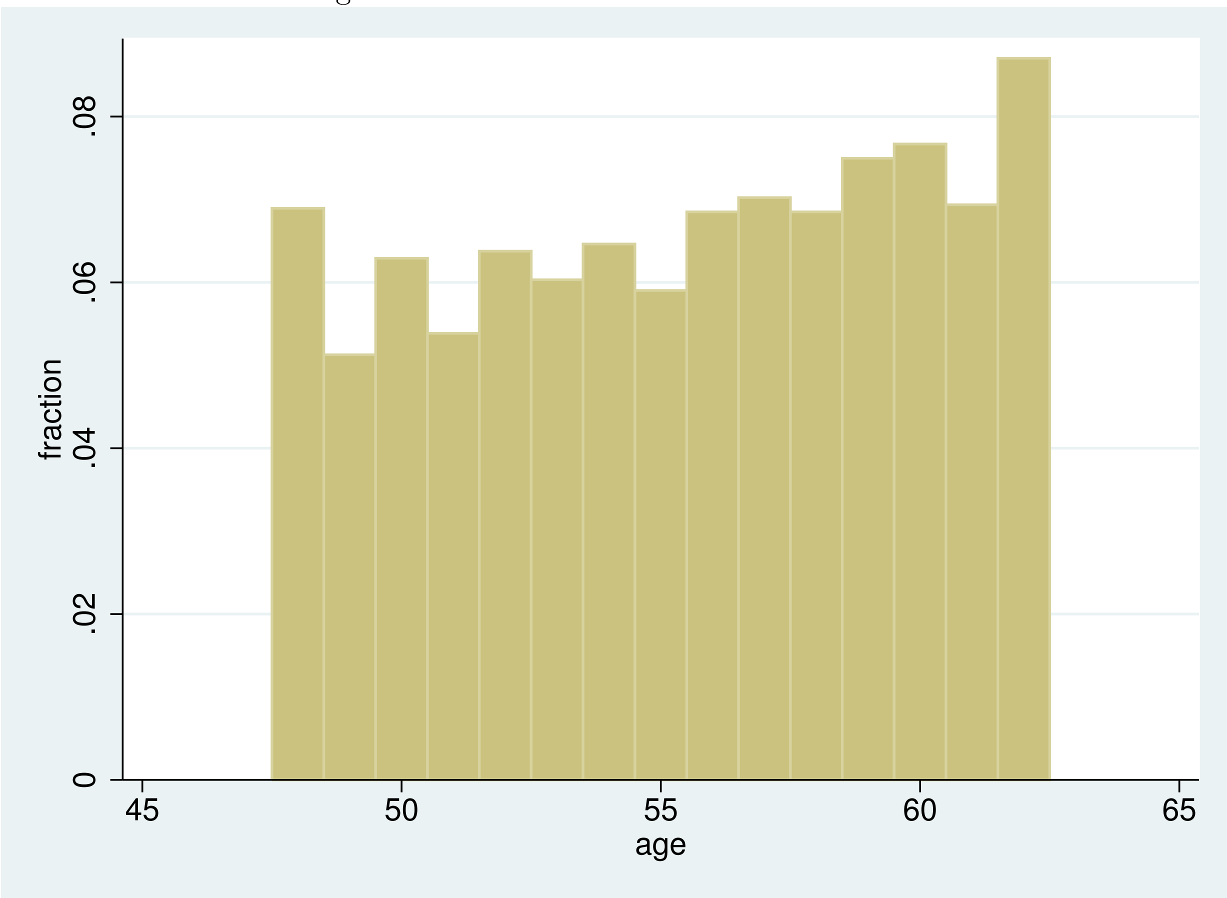
Notes: Estimated age effect on life satisfaction and estimated fraction of each class in linear finite mixture models (with normally distributed error terms) with up to four latent classes (equation (5)).

Figure 8: Fraction of people reaching a minimum or maximum compared to the last ten years



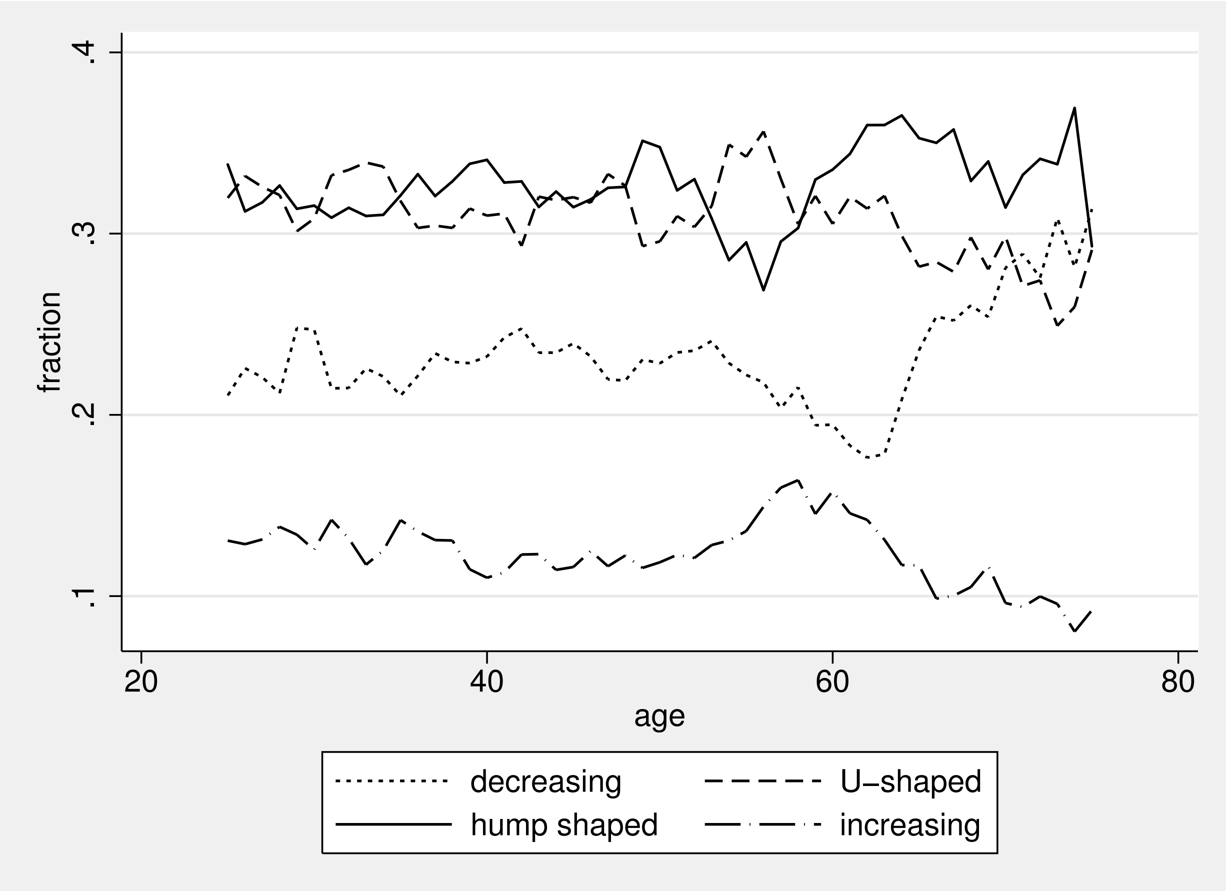
Note: The continuous (dotted) line indicates the fraction of people, who reach at this specific age the lowest (highest) life satisfaction level compared to the last ten years where the minimum (maximum) has not to be unique.

Figure 9: Distribution of observed minimums



Note: Distribution of minimums for people observing between age 48 and 62. Number of people: 979, number of minimums: 2321 (minimum has not to be unique).

Figure 10: Distribution of evolution patterns



Note: Fraction of evolution patterns between 25 and 75. In a first step, for every person and all possible intervals of length eleven, a simple model with two linear terms, one for the first and one for the second part, is estimated: $y = \beta_0 + \beta_1(a\mathrm{I}(t-c-a < 0)) + \beta_2(a\mathrm{I}(t-c-a > 0)) + \epsilon$ if $|t-c-a| \leq 5$, where the standard notation of the paper applies. In a second step, the results are classified ($\beta_1 < 0$ $\beta_2 < 0 \rightarrow$ decreasing, $\beta_1 < 0$ $\beta_2 > 0 \rightarrow$ U-shaped, $\beta_1 > 0$ $\beta_2 < 0 \rightarrow$ hump shaped, $\beta_1 > 0$ $\beta_2 > 0 \rightarrow$ increasing) and the fraction of each type is computed. Reading example: Between 30 and 40 (thus value at age 35), about twenty percent of the individual patterns can be described as decreasing.

Tables

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
life satisfaction	7.138	1.808	0	10
life satisfaction = 0	0.005		0	1
life satisfaction = 1	0.004		0	1
life satisfaction = 2	0.011		0	1
life satisfaction = 3	0.023		0	1
life satisfaction = 4	0.032		0	1
life satisfaction = 5	0.110		0	1
life satisfaction = 6	0.103		0	1
life satisfaction = 7	0.211		0	1
life satisfaction = 8	0.309		0	1
life satisfaction = 9	0.123		0	1
life satisfaction = 10	0.069		0	1
year	1998.0	7.6	1984	2009
age	45.6	15.7	20	80
year of education	11.5	2.6	7	18
female	0.514		0	1
cohort (year of birth)	1952.4	16.5	1904	1989
duration (year in panel)	8.0	6.2	1	26

Notes: Data from GSOEP. The used sample consists of 38,197 different individuals, 304,856 person-year observations, living in (former) West-Germany.

Table 2: Estimated trends in average life satisfaction

	coeff	std. err.
age + time	0.0029	(0.0011)
cohort + time	0.0029	(0.0011)
duration	-0.0295	(0.0015)
constant	6.9753	(0.0180)
Observations	304,856	
Individuals	38,197	

Notes: The table shows the estimation results for (2'). Standard errors in parentheses are corrected for clustering at the individual level. Not shown are nonlinear components of the age profile (60 dummies), of the cohort profile (86 dummies), of the year profile (26 dummies), and of the duration profile (26 dummies). These are together with the trends displayed in Figure 2.